STATISTICS OF INFLUENZA MORBIDITY.

WITH SPECIAL REFERENCE TO CERTAIN FACTORS IN CASE INCIDENCE AND CASE FATALITY.[1]

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Because of the incompleteness and lack of uniformity in reports of influenza morbidity, the only comprehensive statistical record of the recent pandemic must be based on records of mortality. While this deficiency of morbidity records is by no means peculiar to influenza, it is nevertheless a serious obstacle to broad epidemiological studies, which require for their basis accurate records of the occurrence of infection in various demographic units. Owing to the variable factor of case fatality, statistics of mortality alone do not afford an accurate measure of relative case incidence, so that analysis of mortality alone may fail to bring out important epidemiological features, or, still worse, may point to erroneous conclusions.

The statistics which are here discussed were collected by the Public Health Service by special canvasses made in 10 cities ranging in population from 25,000 to 600,000, and in several smaller cities and rural areas in Maryland,[2] the latter being considered together as a single statistical group. It was necessary to limit the studies for the most part to communities in which the Public Health Service was at the time maintaining previously established organizations prepared to collect the requisite data reliably and efficiently; but notwithstanding these limitations the communities canvassed represent widely separated sections of the United States. Figure 1 shows the location of the communities where canvasses were made, and for each community the total population (estimated roughly and expressed in round numbers) and the population included in the canvass.

Data were collected by intelligent inspectors working under specific detailed instructions and careful supervision. In each locality these inspectors made a house-to-house canvass in 10 or more enumeration districts, so chosen as to give, presumably, a fair sample of the general population. The effort was made to canvass in each city not less than about 5,000 persons, in order to secure a group sufficient for simple statistical analyses; and in cities of more than 100,000 population, to increase this number to give not less than about 5 per cent of the total population. These conditions were generally fulfilled.

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[1] Read before the section on vital statistics, American Public Health Association, New Orleans, La., Oct. 30, 1919.

[2] The results of these surveys will be presented later in more detail. Partial presentations of some of the statistics here cited have already been made, viz—

Influenza in Maryland: Preliminary Statistics of Certain Localities, by W. H. Frost and Edgar Sydenstricker. Public Health Reports, vol. 34, No. 11, Mar. 14, 1919.

The Epidemiology of Influenza, by W. H. Frost. American Med. Jour., vol. 73, No. 5, Aug. 2, 1919. Reprinted in Public Health Reports, vol. 34, No. 33, Aug. 15, 1919.

Regarding each individual in the canvassed populations, the inspectors recorded the name, color, sex, and age at last birthday; whether or not sick since September 1, 1918, with influenza, pneu-

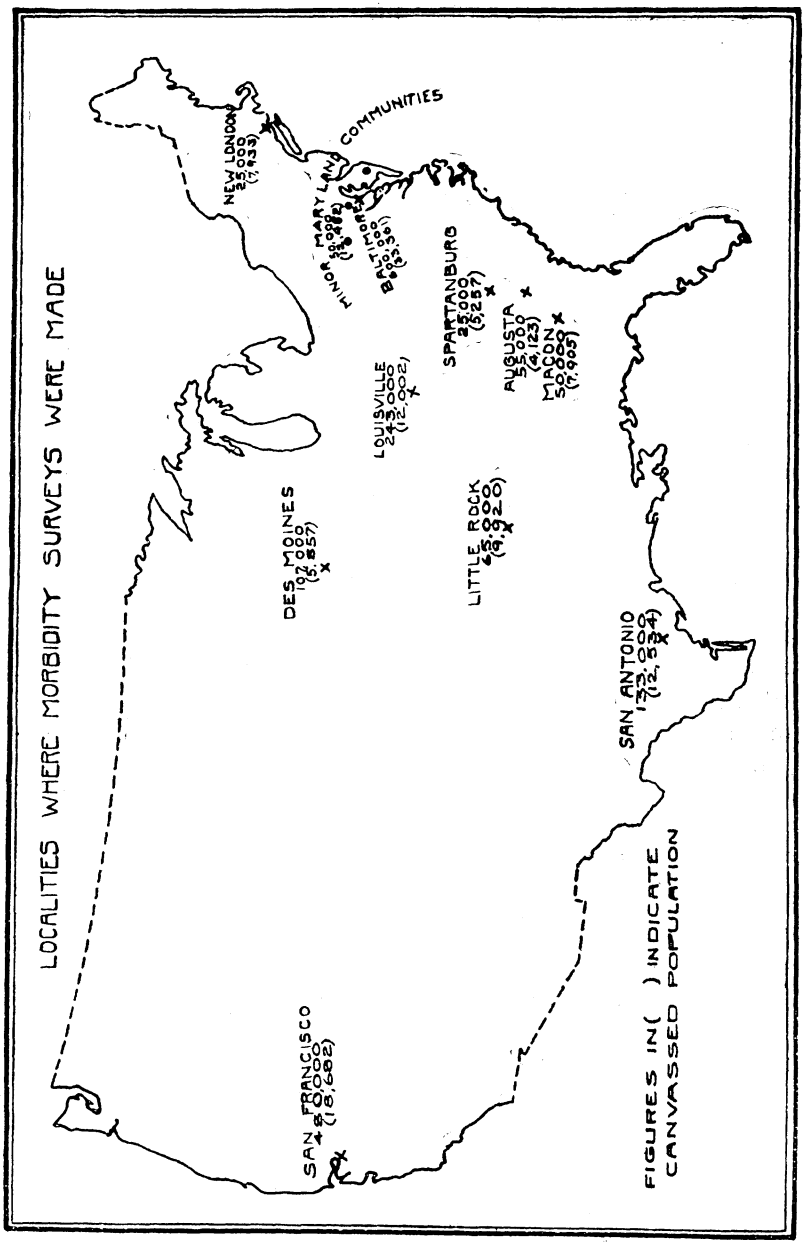

Fig. 1.

monia, or indefinitely diagnosed illness suspected to be influenza. Regarding each case of such illness, the facts recorded were the nature of the illness, i. e., whether influenza, pneumonia, or doubtful,

date of onset, duration of illness, and date of death if death resulted. Regarding each household, the inspectors recorded the number of rooms occupied and their impressions of the economic status of the family, whether well-to-do, moderate, poor, or very poor. This economic classification being merely an expression of the general impressions of a number of inspectors is of course a very rough one.

The precision of data secured in this way can not be discussed in detail within this space, but it may be said that with full appreciation of the sources of error the results are believed to be fairly accurate and reliable for the purposes to which they are applied. The canvass was made, in each locality, as soon as possible after the epidemic appeared to have definitely subsided, necessarily judging of this by current morbidity and mortality reports. In Baltimore and San Francisco, where the first canvass was completed in December, a second canvass was made in January and February to obtain record of a recrudescence which had taken place in the interval. In Louisville, where the canvass was completed December 27, the Weekly Health Index records of mortality indicate that the epidemic continued at a relatively low level through January and February, with a definite exacerbation during March. Presumably, therefore, a considerable number of cases occurred in Louisville after the case canvass had been made. In all other localities the canvass is believed to have comprised practically the whole of the epidemic period.

The course of the epidemic, as indicated by the weekly case-incidence rate, was widely different in the various localities studied. In New London, in Baltimore and other Maryland communities, and in Little Rock, the epidemic was sharply explosive, developing mostly in one phase of six to eight weeks' duration. In San Francisco the curve was similar but less acute and showed a considerable secondary recrudescence. In Spartanburg, Augusta, Macon, Louisville, and Des Moines, the epidemic was decidedly more protracted in its course; and in San Antonio the curve showed two distinct and approximately equal peaks, reached in the weeks ended October 19 and December 7, respectively. These differences are illustrated in Figure 2, which shows the curves of case incidence in five localities.

In five of the cities canvassed, records of weekly mortality from influenza and pneumonia in the total population are available for comparison with the weekly case incidence in the samples of population canvassed. As shown in Figure 2, the mortality curves in these cities conform to the curves of case incidence in general shape and in chronology, with a lag of about one week as expected.

So far as these few examples justify any conclusion, it would appear that for purposes of comparison between different communities with respect to the chronology of the epidemic, mortality statistics give results quite similar to those derived from morbidity statistics.

However, the varying ratio of case incidence to mortality may introduce wide discrepancies into the quantitative analysis of curves based on these two sets of data. For example, it is evident from inspection of Figure 2 that the relative values of epidemicity indices com-

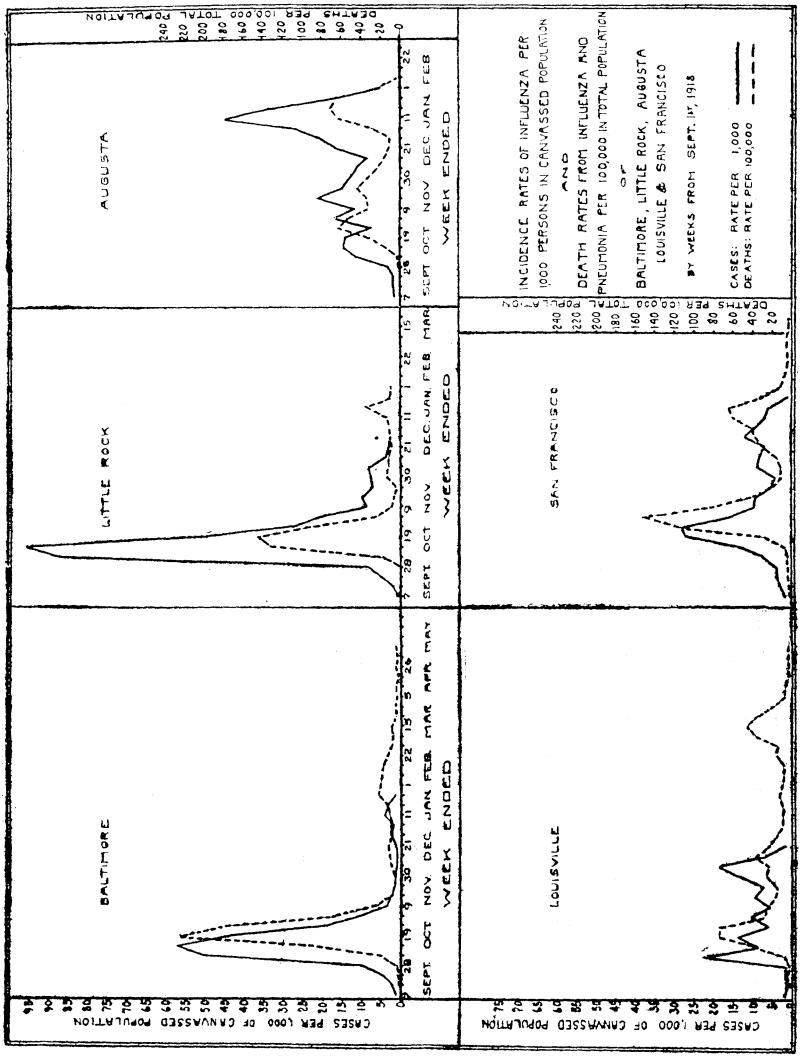

Fig. 2.

puted for Baltimore and Little Rock from mortality statistics according to the method recently applied by Pearl [1] would be quite different from those of indices similarly computed on the basis of morbidity statistics.

[1] Pearl, Raymond, Influenza Studies: Public Health Reports, vol. 34, No. 32, Aug. 8, 1919.

Factors in Case Incidence.

The gross attack rates per 1,000 persons canvassed in the several localities are shown in the following summary. These rates are based on the total epidemic morbidity, including cases classed as "influenza," "pneumonia" and "doubtful," the last class constituting not more than 10 per cent of total cases in any locality.

Incidence rates of influenza per 1,000 persons canvassed in 11 localities.

Louisville [1]	150	Baltimore	246
New London	185	Augusta	341
Macon	213	Little Rock	359
Spartanburg	214	Minor communities in Maryland	405
San Francisco	215	San Antonio	535
Des Moines	231	All localities	280

[1] Canvass concluded before epidemic had run its full course.

The range of variation is considerable, the attack rate in San Antonio having been nearly three times that in New London; but in five of the localities, geographically widely separated, the incidence rate varied only within narrow limits, namely, from 200 to 250 per thousand. Variations in attack rate show no apparent consistent relation to geographic location or size of community, or to the rapidity of development of the epidemic.

Age.—Within each locality characteristic variations in incidence rate are noted in relation to color, sex, and age, the factor of widest and most constant variation being age. The nature and extent of the variations in case incidence in relation to age are illustrated in Figure 3, showing for all localities and for each locality the ratio of incidence in each age group to incidence at all ages in that locality, the latter rate having been first adjusted in every case to a uniform basis of sex and age distribution.[1]

Considering the statistics of all localities combined, the attack rate was highest in the age group 5 to 9, declining with almost unbroken regularity in each successive higher age group. An exception to this regular decline occurs in the age groups 25 to 34, in which the attack rates are higher than in the age groups 15 to 24. Considering individual localities, minor differences are noted in the relative incidence in various age groups; but on the whole the essential similarity is much more striking than these slight differences, indicating that a selective incidence in relation to age was a marked characteristic of this epidemic.

[1] The standard population used for this and similar rate adjustments mentioned later is the total population of the Continental United States, males and females, by five-year age periods, as per census enumeration of 1910.

Sex.—With few exceptions the attack rate at all ages was found to be somewhat higher in females than in males. Since the normal ratio of males to females, especially between the ages of 15 and 34, was found in our surveys to have been considerably disturbed, due to withdrawals of males for military service, the incidence rates

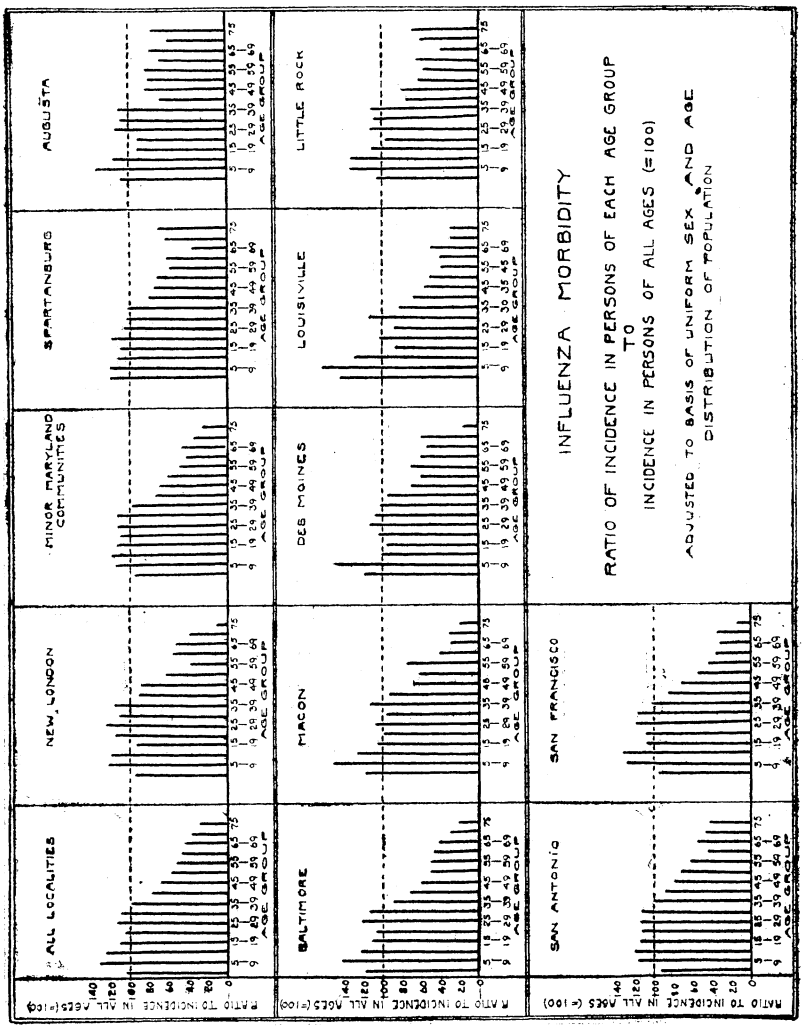

FIG. 3.

among males and females, respectively, have been adjusted to a normal age distribution for each sex as existing in 1910. The ratios of incidence in females to incidence in males, based on actual and adjusted rates, are shown in the following summary:

Ratio of incidence among females to incidence among males in all localities and in each locality canvassed. Comparisons based on actual and adjusted rates.

Localities.	Ratio of incidence in females to incidence in males (=100).	
	Actual rates.	Adjusted rates.
All localities	106	106
Macon	119	118
Minor Maryland communities	106	113
Spartanburg	113	110
Baltimore	108	109
New London	106	104
San Francisco	105	104
San Antonio	104	103
Augusta	99	102
Des Moines	103	101
Louisville	95	99
Little Rock	100	98

Considering all localities, the excess of incidence in females was 6 per cent. Considering individual localities the differences ranged from an excess of 19 per cent to a deficiency of 2 per cent, a lesser incidence among females being shown in only 2 of the 11 localities.

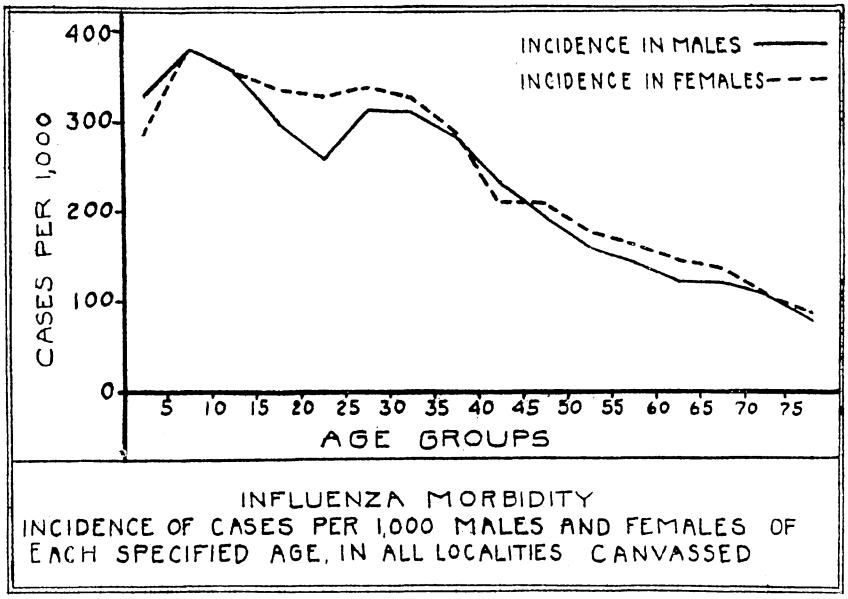

FIG. 4.

The incidence rates for all localities in males and females, respectively, of each five-year age group, are shown in Figure 4, from which it is seen that the incidence in females was higher in each age period except under 5, 10 to 14, 40 to 44, and 70 to 74. The excess of incidence in males in these groups is relatively small and is hardly significant in the highest age group where the rates are computed from small figures. The most striking excess of incidence in females occurs between the ages of 25 and 40, the difference between the

sexes being relatively slight in age periods above and below these limits. These facts indicate that in general, females over the age of 15, especially between the ages of 15 and 45, were either more susceptible to infection or more generally and more intimately exposed than males of corresponding age.

Color.—In all localities canvassed the colored population comprised in the canvass was considerably smaller than the white, constituting

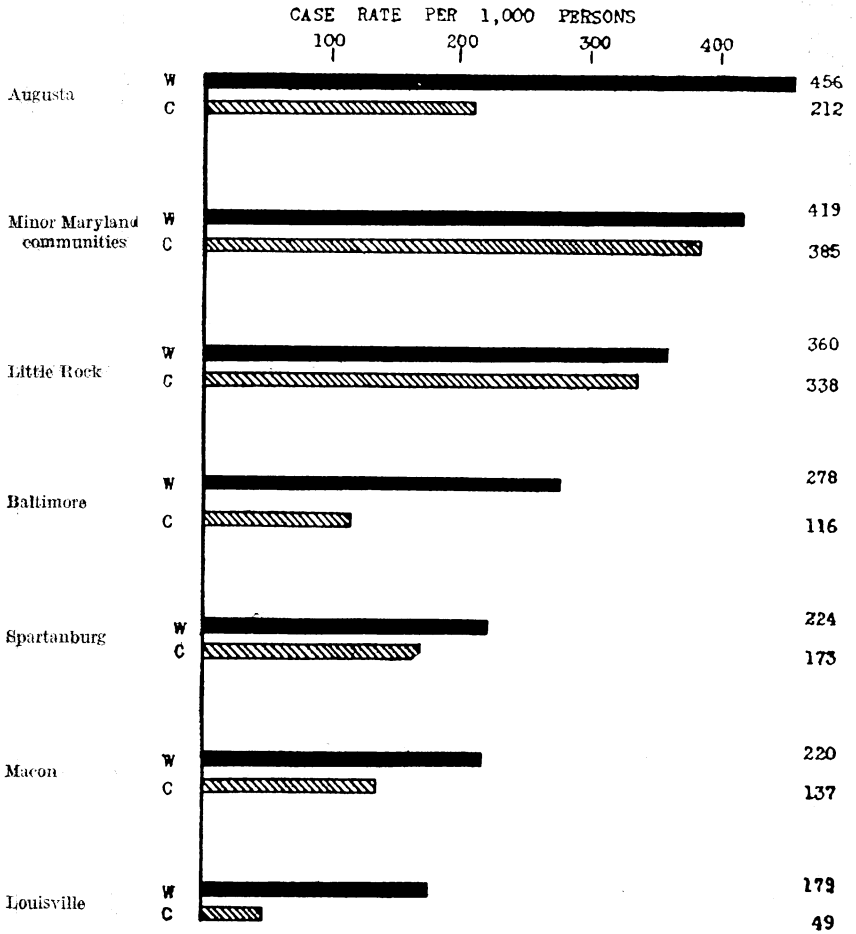

FIG. 5.—Influenza: Incidence rates per thousand in white and colored population of seven localities.

in some localities a group too small for any significant comparison between the races. In the 7 localities with considerable colored populations, the incidence rates among the colored were uniformly lower than among the white, the differences persisting after adjustment of the rates to a uniform basis of sex- and age-distribution. As shown in Figure 5, the extent of the difference varied, being relatively great in Baltimore, Augusta, and Louisville, and very small in Little

Rock. This relatively low incidence in the colored race is quite contrary to what would have been expected a priori in view of the facts that the death rate from pneumonia and influenza is normally higher in the colored than in the white, and that the colored population live generally under conditions presumably more favorable to the spread of contact infections.

Domestic environment.—Data regarding the relation of case incidence to economic status have so far been analyzed only for Little Rock and San Antonio. Classifying the white populations canvassed in these two cities according to economic status, and adjusting the incidence rate in each group to a uniform sex- and age-distribution, the ratios of incidence in each group to incidence in the total white population of the respective cities are found to be as shown in the following summary:

Ratio of incidence rates in white persons of four economic groups to incidence in total white population. All rates adjusted to uniform sex and age distribution.

Group.	Ratio of incidence in each group to incidence in total white population.	
	Little Rock.	San Antonio.
Total white population	100	100
Well-to-do	92	93
Moderate	107	100
Poor	126	105
Very poor	114	103

Notwithstanding that the classification according to economic status is a very loose one, based solely on the judgment of inspectors with widely different standards, a considerably higher incidence is shown in the lower as compared to the higher economic groups. In both cities the group designated as "very poor" is quite small, so that the difference in incidence rate between this group and the group classed as "poor" is of little significance.

Only for Little Rock have our statistics been analyzed with reference to housing space. The following summary compares the incidence in white population groups, classified according to the number of rooms occupied per person in the household, to incidence in the total population, all rates having been adjusted to uniform age-and-sex distribution:

Housing classification.	Ratio to incidence in total white population.
Total, all classes (white)	100
More than 1.5 rooms per person	77
1 to 1.5 rooms per person	94
Less than 1 room per person	117

As might be expected, the attack rate shows a consistent increase as the number of rooms per person decreases. This does not, of course, indicate that housing space *per se* is a factor of such relative importance in case incidence, since the groups distinguished on this basis are presumably not equivalent with respect to various other features of environment. However, these limited statistics at least suggest that the immediate domestic environment is a factor of some importance in the influenza attack rate, the tendency being toward a higher morbidity under the complex of conditions associated with relative poverty. If this tendency in the white population should prove on further analysis to be a general one, it still further emphasizes the difference already noted between the white and colored attack rates.[1]

Case Fatality.

The case fatality, or ratio of deaths to total cases of influenza, varied in the localities surveyed from 3.1 per cent in New London to 0.8 per cent in San Antonio, the variations showing no consistent relation to incidence rates. There is, however, some relation to geographic location, namely, that the highest case-fatality rates occurred in New London, San Francisco, Baltimore, and minor Maryland communities, in the order named—that is, in communities representing, respectively, the northern half of the Atlantic seaboard and the Pacific coast. In the central and southern cities the case fatality was generally notably lower. Combining the eleven localities into three groups comprising, respectively—(1) San Francisco, (2) New London, Baltimore, and minor Maryland communities, (3) central and southern cities, comprising all other localities, the case-fatality rates in these three groups are, respectively, 2.33, 2.05, and 1.08 per cent. This is of interest in connection with the observation that from the standpoint of mortality rates the epidemic was generally more severe along the northern Atlantic Seaboard and the Pacific Coast than in the Central States.

Sex and age.—Variations in case fatality according to sex and age, in all localities combined, are shown in Figure 6. In males the fatality reached a high point in three age groups, namely, under 5, from 20 to 40, and over 60 years. In females the case fatality was correspondingly high in ages under 5 and over 60, relatively less high in the ages 20 to 40. Under the age of 15 and over the age of 60 the case fatality was consistently higher among females than among males; while between the ages of 15 and 60 the reverse was true, the difference being greatest between the ages of 20 and 40.

In most of the localities canvassed, the number of deaths included in our statistics is too small to permit of a fair comparison between

[1] Subsequent more detailed analyses of the statistics from the other cities canvassed have shown fairly consistent correlations between economic status and housing space, and case-incidence, as here noted for Little Rock and San Antonio.

males and females grouped according to five-year age-periods; hence, in order to test the consistency of variations in case fatality according to sex and age, statistics have been analyzed by sex and broad age-periods for four groups of localities as follows:

Group I. All localities combined;

Group II. New London, Baltimore, and minor Maryland communities, that is, all communities on the northern Atlantic seaboard;

Group III. Localities in the Southern and Central States;

Group IV. San Francisco.

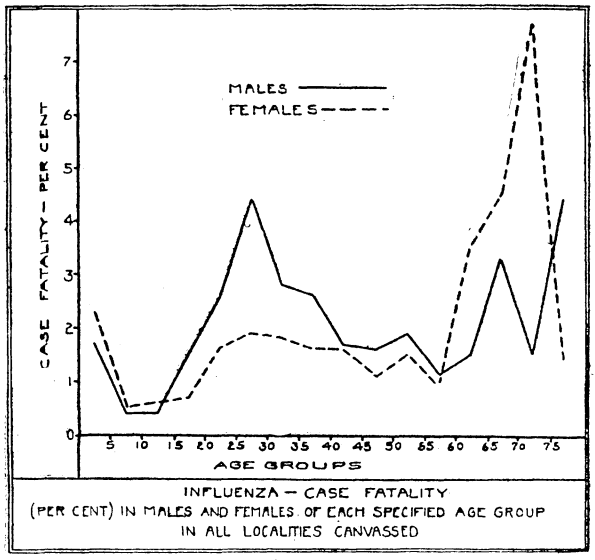

FIG. 6.

Figure 7 shows for these four groups the variations in case incidence, case fatality, and death rate in relation to sex and age. In all the groups the case incidence in persons over 15 years of age was higher in females than in males, this difference being consistent throughout except that in San Francisco in the age group 45 to 49 the incidence rates in the two sexes were approximately the same (males 131, females 132 per 1,000). In persons under 15 the relative incidence as between males and females is variable, but with a very slight excess in males for all the localities combined.

The case fatality under 15 years of age was higher in females than in males in all groups except San Francisco; and over 60 years of age it was considerably higher among females in all four groups. On the other hand, between the ages of 15 and 60, the general tendency is to a much higher case fatality among males. With respect to case fatality between the ages of 15 and 45, the group of southern and central cities is in marked contrast to the other groups, the case fatality being remarkably low in both sexes and slightly higher in females than in males. In so far as these few localities and comparatively small figures may be considered a reliable index, they

suggest that in the South and Middle West where the epidemic was generally milder in respect of mortality than in the Northeast and far West, the essential difference was not in case incidence, but in case fatality, especially in persons from 15 to 45 years of age, and in the relatively low case fatality among young adult males.

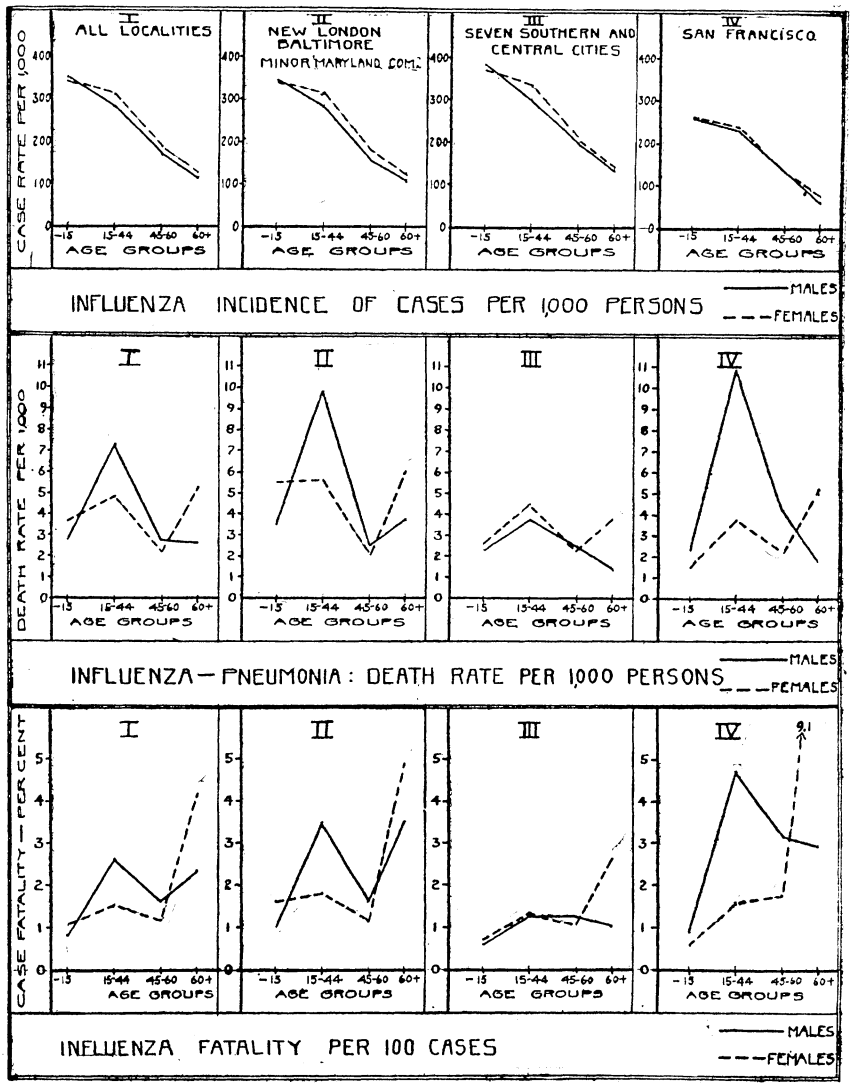

FIG. 7.

The death rates per 1,000 persons in each geographic, sex, and age group, as shown in Figure 6, are the resultant of two factors—case incidence and case fatality. It is evident, however, that the relative mortality in these various groups is determined more largely by case fatality, which varies within wider limits than does case incidence,

and so without a full and exact knowledge of the variations in case fatality, statistics of mortality are by no means translatable to terms of relative morbidity.

A further analysis of the remarkable differences in case fatality according to sex and age is presented in Figure 8, showing for males and females of each age group, for all localities combined, the incidence rate of pneumonia per 1,000 persons, and the ratio of deaths to pneumonia cases. Comparing these graphs with Figure 5 the lower

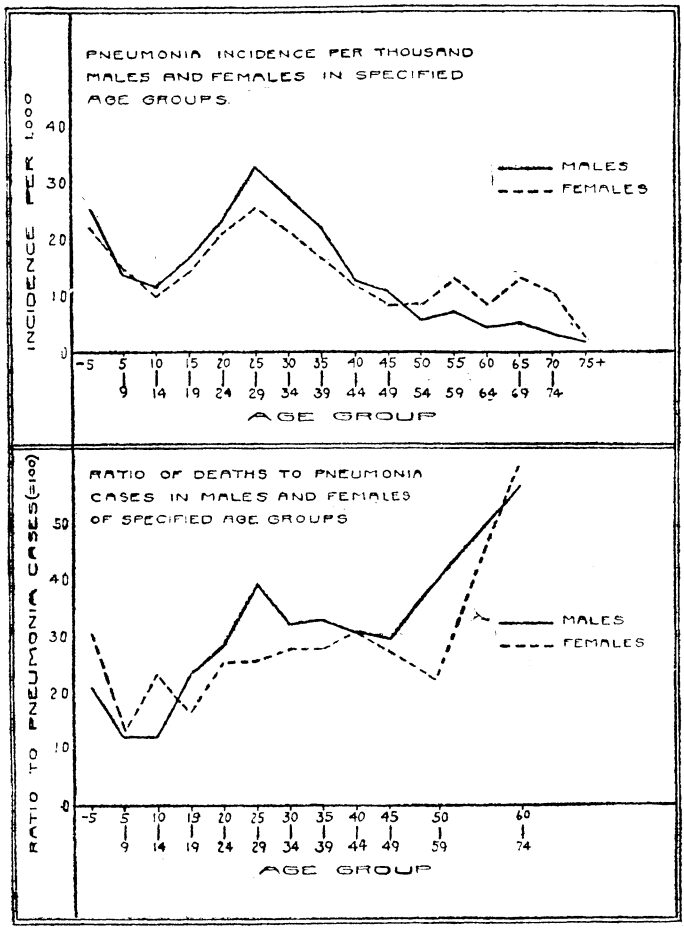

FIG. 8.

influenza case fatality in females from 15 to 60 years of age as compared to males, appears to be accounted for in part by a lesser incidence of pneumonia, and in part by a lower fatality of pneumonia cases. Indeed, the curves of pneumonia incidence and case fatality show a very striking parallelism with the curve of case fatality in relation to sex and age in general.

Color.—Comparing the white and colored populations in the seven localities where considerable numbers of colored persons were included in our canvass, the case fatality is found to have been gen-

erally higher among the colored, as shown in Figure 9. The number of deaths in some of the population groups is so small that no attempt has been made to adjust the case-fatality rates for differences between the races in sex- and age-distribution.

Summary.

As to the value of the statistics discussed above, they represent so few localities and such a small number of observations (130,033 persons, 36,365 cases, and 583 deaths) that, taken alone, they contribute

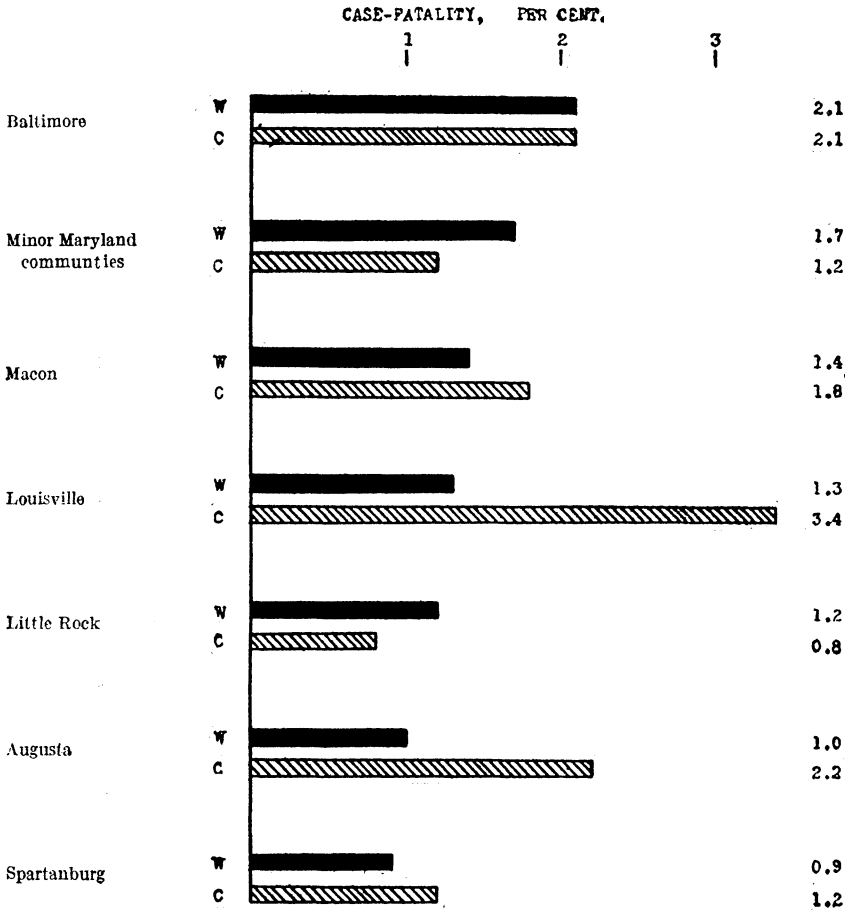

FIG. 9.—Influenza: Case-fatality (per cent) in white and colored persons, respectively, in seven localities.

little towards giving a picture of the epidemic in the country at large. Nevertheless, considered in connection with the far more extensive mortality statistics available elsewhere, they have a definite significance, for even though they do not suffice for the conversion of mortality statistics into terms of morbidity, they at least indicate in a general way some highly important relations between morbidity and mortality, relations which must be borne in mind in applying mortality statistics of the epidemic to various important purposes of epidemiology.